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IS : 4859 - 1968

Indian Standard

Reaffirmed 2009

SPECIFICATION FOR
HIGH STRENGTH AIRCRAFT PLYWOOD

(First Reprint SEPTEMBER 1983)

UDC 674.243 : 629.13



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INDIAN STANDARDS INSTITUTION
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
NEW DELHI 110002

Gr 5

February 1969

Indian Standard

SPECIFICATION FOR HIGH STRENGTH AIRCRAFT PLYWOOD

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**AMENDMENT NO. 1 MARCH 2001
TO
IS 4859 : 1968 SPECIFICATION FOR HIGH
STRENGTH AIRCRAFT PLYWOOD**

(Page 11, clause 4.16) — Substitute the following for the existing:

'4.16 Treatment of Boards — Boards shall be treated with either trichlorophenol dissolved in light organic solvent or sodium pentachlorophenate dissolved in water to a retention level of 8 kg/m³ or 6 kg/m³ respectively.'

(CED 20)

Reprography Unit, BIS, New Delhi, India

**AMENDMENT NO. 2 MARCH 2005
TO
IS 4859 : 1968 SPECIFICATION FOR
HIGH STRENGTH AIRCRAFT PLYWOOD**

(Page 7, clause 3.2, third line) — Substitute 'IS 848 : 1974*' for 'IS : 848 - 1957*'.

(Page 7, footnote marked *) — Substitute the following for the existing footnote:

'*Specification for synthetic resin adhesives for plywood (phenolic and aminoplastic) (first revision)'

(Page 11, clause 5, and page 12, Table 2) — Substitute the following for the existing:

5 DIMENSIONS AND TOLERANCES

5.1 The dimensions of plywood panels shall be as follows:

1 800 mm × 1 200 mm	1 800 mm × 900 mm
1 500 mm × 1 200 mm	1 500 mm × 900 mm
1 200 mm × 1 200 mm	1 200 mm × 900 mm

5.2 Thickness

The thickness shall be 1.0 mm, 1.5 mm, 2.0 mm, 2.5 mm, 3.0 mm, 3.5 mm, 4.0 mm, 4.5 mm, 5.0 mm, 6.0 mm, 7.0 mm, 8.0 mm, 9.0 mm and 10.0 mm.

NOTE — Any other dimensions (length, width and thickness) as agreed to between the manufacturer and the purchaser may also be used.

5.3 Tolerances

Tolerances on the nominal sizes of finished boards shall be as given below:

<i>Dimension</i>	<i>Tolerance</i>
Length	+6 -0 mm
Width	+3 -0 mm

Amend No. 2 to IS 4859 : 1968

Thickness

- | | |
|--------------------|------------------|
| i) Less than 6 mm | ± 10 percent |
| ii) 6 mm and above | ± 5 percent |

Edge straightness

2 mm per 1 000 mm or 0.2 percent

Squareness

2 mm per 1 000 mm or 0.2 percent

NOTE — Edge straightness and squareness shall be tested as per Annex A

(Page 12, clause 7.1) — Substitute 'IS 1734 (Part 5) 1983*' for 'Appendix A of IS 709 1957*' in the fifth line and 'Annex B' for 'Appendix A' in the sixth line

(Page 12, footnote) — Substitute the following for existing footnote

*Method of test for plywood Part 5 Test for adhesion of plies

(Page 13, clause 9.1) — Substitute 'Annex C' for 'Appendix B' in second line.

(Page 13, clause 10.1) — Substitute 'Annex D' for 'Appendix C' in first line

(Page 13, clause 10.2.2) — Substitute 'Annex E' for 'Appendix D' in second line

(Page 13, clause 10.2.3) — Add the following new clause after 10.2.3.

10.3 Static Bending Strength — Three test specimens taken in each direction from the sample of plywood, when tested in accordance with IS 1734 (Part 11) . 1983 shall have an average and a minimum individual Modulus of Elasticity and Modulus of Rupture not less than the values specified in Table 2

Table 2 Modulus of Elasticity (MOE) and Modulus of Rupture (MOR)

Direction	MOE (N/mm ²)		MOR (N/mm ²)	
	Average	Min Ind	Average	Min Ind
(1)	(2)	(3)	(4)	(5)
Along (Direction parallel to the grain direction of the face veneer)	7 500	6 700	50	45
Across (Direction perpendicular to the grain direction of the face veneer)	4 000	3 600	30	27

(Page 14, clause 13.2.2) — Insert the following Annex A after clause 13.2

ANNEX A
(Clause 5.3)

**METHOD OF TEST FOR EDGE STRAIGHTNESS AND
SQUARENESS**

A-1 PROCEDURE FOR EDGE STRAIGHTNESS

A-1.1 The straightness of the edges and ends of plywood shall be verified against a straight edge not less than the full length of the plywood. If the edge on the end of the plywood is convex, it shall be held against the straight edge in such a way as to give approximately equal gap at each end. The largest gap between the straight edge and the edge shall be measured to the nearest millimetre and recorded.

A-2 PROCEDURE FOR SQUARENESS

A-2.1 The squareness of plywood shall be checked with a 1 200 mm × 1 200 mm square, by applying one arm of the square to the plywood. The maximum width of the gap shall be recorded.

(Page 15, Appendix A) — Rename 'Appendix A' as 'Annex B'

(Page 16, Appendix B) — Rename 'Appendix B' as 'Annex C'

(Page 17, Appendix C) — Rename 'Appendix C' as 'Annex D'

(Page 18, Appendix D) — Rename 'Appendix D' as 'Annex E'

**AMENDMENT NO. 3 DECEMBER 2005
TO
IS 4859 : 1968 SPECIFICATION FOR
HIGH STRENGTH AIRCRAFT PLYWOOD**

[*Page 11, clause 5.3 (see also Amendment No 2)*] — Substitute the following for the existing at SI No (1) of Thickness

‘ 1) Less than 6 mm \pm 10 percent ’

(CED 20)

Reprography Unit, BIS, New Delhi, India

Indian Standard

SPECIFICATION FOR HIGH STRENGTH AIRCRAFT PLYWOOD

0. FOREWORD

0.1 This Indian Standard was adopted by the Indian Standards Institution on 17 November 1968, after the draft finalized by the Wood Products Sectional Committee had been approved by the Civil Engineering Division Council.

0.2 Medium strength aircraft plywood suitable for use mainly in secondary structural parts of aircrafts and gliders has been covered in IS : 709-1957*. However, for use in primary structural parts of aircraft, high-strength plywood is needed. This standard has, therefore, been formulated to lay down the requirements of high strength plywood for use in primary structural parts of aircraft.

0.3 In the formulation of this standard due weightage has been given to international co-ordination among the standards and practices prevailing in different countries in addition to relating it to the practices in the field in this country.

0.4 This standard contains clause 3.2.2 which permits the purchaser to specify the type of adhesive required for binding of the veneers.

0.5 For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test or analysis, shall be rounded off in accordance with IS:2-1960†. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

1. SCOPE

1.1 This standard lays down the requirements for strength, quality, bonding and manufacture of high strength aircraft plywood suitable for use in the manufacture of primary structural parts of aircraft.

*Specification for medium strength aircraft plywood.

†Rules for rounding off numerical values (revised).

2. TERMINOLOGY

2.0 For the purpose of this standard, definitions given in IS:707-1968* and the following shall apply.

2.1 Back — The side of the panel opposite to the face.

2.2 Batch — Plywood boards of the same thickness produced from the same material and on the same day in one press from the same roll of film adhesive or mix of adhesives.

2.3 Blister — Spot or area where the veneers do not adhere together properly and bulge like a blister.

2.4 Bird's Eye — A small roughly circular marking due to contorted grain.

2.5 Brash Wood — Wood which breaks with a short fracture, that is with little or no splintering due to fungal attack or other causes.

2.6 Burr — A lump or a knot on the base of a tree trunk.

2.7 Check — A separation of the fibres extending along the grain which does not affect the entire thickness of a veneer or ply.

2.8 Core — The inner layer or layers of plywood.

2.9 Decay — Disintegration of wood tissues caused by wood-destroying fungi.

2.10 Delamination — Separation of adjacent plies partial or complete caused by poor or defective glue adhesion.

2.11 Discolouration — Patch of a colour differing from that normally associated with the species and occurring in either streaks or patches.

2.12 Dote — Patch or streak of decay differing from surrounding wood chiefly in colour indicating incipient decay. It may be lighter or darker than the normal.

2.13 Edge Joint — A joint made between two veneers in the general direction of the grain.

2.14 End Joint — A joint made between two veneers across the grain.

2.15 Extender — A substance added mainly to reduce the cost of gluing.

2.16 Face — The better side of the panel in any grade calling for a face and a back; also either side of a panel where the grading rules draw no distinction between faces.

2.17 Filler — An inert substance, such as wood flour, added to alter the characteristics (for example to reduce brittleness) of a synthetic resin.

*Glossary of terms applicable to timber and timber products (*first revision*).

2.18 Gap — A void in the core due to a split or edges of adjacent veneers not being close.

2.19 Insect Hole (Borer Hole) — A hole caused by the attack of wood-boring insects.

2.19.1 Harmless Insect Hole (Borer Hole) — Insect hole with no living borers, and not exceeding 1.6 mm in diameter.

2.20 Irregular Grain — A comprehensive term, covering all cases where the grain, noticeably, is not parallel to the appropriate edges and to the face of the veneer. The main forms of irregular grain are short grain, wavy grain and wild grain.

2.20.1 Short Grain — This results from crook in the log. It is also present in more acute form surrounding or in close proximity to knots, when it is caused by the knife of the veneer cutting machine cutting across the wood with which the branch was enveloped in the growing tree; in such instances the inclination of the grain to the face of the veneer may approach 90° in the extreme case.

2.20.2 Wavy Grain — The fibres are wavy, but the waviness is in the plane of the veneer. Where waviness is present it is generally fairly uniform and continuous.

2.20.3 Wild Grain — Wild grain occurs when the log has a corrugated exterior. When such a log is peeled the fibres run in and out of the surface of the veneer in transverse bands corresponding to the ridges on the log. The evenness of the peeling cut is disturbed, resulting in a ridged surface in these bands, in addition to the inclined growth.

2.21 Knot — A portion of a branch embedded in the wood by the natural growth of the tree.

2.21.1 Dead Knot — A knot not firmly joined throughout to the surrounding wood, sometimes including bark.

2.21.2 Decayed Knot — A knot which, due to advanced decay, is not as hard as the surrounding wood.

2.21.3 Intergrown Knot (or Tight Knot) — A knot whose rings of annual growth are completely intergrown with those of the surrounding wood.

2.21.4 Live Knot (or Sound Knot) — A tight knot free from decay and cracks, firmly joined throughout to the surrounding wood.

2.22 Metal Clip or Staple — Fastener used in the assembly of plywood to prevent movement of the veneers during processing. (The fasteners are removed from the finished product.)

2.23 Overlap — A ridge-like elevation noticeable on the surface of plywood due to overlapping of two adjacent core veneers.

2.24 Patch—A piece of sound veneer placed in and glued to a veneer from which the defective portion has been removed.

2.25 Pleat—A defect due to a veneer being folded parallel to the grain forming three thicknesses locally.

2.26 Ply—The individual layer of veneer forming the plywood.

2.26.1 Three-Ply—Plywood board made of three layers of veneer.

2.26.2 Multi-Ply—Plywood board made of more than three layers of veneer.

2.27 Plywood—A board formed of three or more layers of veneer cemented or glued together usually with the grain of adjacent veneers running at right angles to each other.

2.28 Scarf Joint—A joint made by bonding together two bevelled edges.

2.29 Split—A separation of the fibres along the grain in a veneer extending from face to face.

2.29.1 Closed Split—A split in which the two adjacent edges are in close contact with each other.

2.29.2 Open Split—A split in which the two adjacent edges are not in close contact with each other.

2.30 Tape—Strip of gummed paper or similar material used to hold together the edges of a joint or split during manufacture.

2.31 Veneer—A thin sheet of wood of uniform thickness produced by slicing or rotary-cutting.

2.32 Warp—Distortion due to stresses causing departure from a plane or true form.

3. MATERIAL

3.1 Timber—Unless otherwise specified by the purchaser the timber for manufacture of aircraft plywood shall be as given in Table 1.

**TABLE 1 SPECIES OF TIMBER FOR MANUFACTURE OF
AIRCRAFT PLYWOOD**

BOTANICAL NAME	TRADE NAME	ABBREVIATED SYMBOL
<i>Dysoxylum malabaricum</i> Bedd.	White cedar	WCE
<i>Palasium ellipticum</i> (Dalz) Engles	Pali	PAL

3.1.1 In selecting the species for manufacturing of plywood it is recommended that as far as possible a single species of timber be used for all plies; where combination of species is used, a single species of timber should be used for both face and back plies and care should be taken to prevent incompatibility of species.

NOTE — Other species of timber, such as (a) rosewood (*Dalbergia Latifolia* Roxb), (b) sissoo (*Dalbergia sissoo* Roxb), (c) walnut (*Juglans* sp), (d) padauk (*pterocarpus dalbergioides* Roxb), (e) teak (*Tectona grandis* Linn f), (f) mullilam (*Fagara budnunga* Roxb), (g) sandan (*Ongetria oojeinensis*), (h) padri (*stereospermum* sp), (j) debadaru (*Polyalthia* sp), and (k) hollock (*terminalia myriocarpa* Heurck et Muell. Arg) may also be used provided that the construction is established to be satisfactory in actual use and in addition the performance specified in this standard is satisfied.

3.2 Adhesive — Adhesive used in the manufacture of aircraft plywood shall be of the hot press, thermosetting, synthetic resin type and shall conform to BWR Grade of IS: 848-1957*. Extenders shall not be added to the adhesive but addition of a dye to check that all parts of the veneer are completely covered by adhesive shall be permissible.

3.2.1 No alternative adhesive shall be used without the prior approval of the purchaser.

3.2.2 The purchaser, if he so desires, shall specify the type of adhesive, namely liquid or film to be used for binding of the veneers. Unless specifically mentioned the manufacturer shall be at liberty to use either of the types.

4. MANUFACTURE

4.1 Veneers — The veneers shall be either rotary cut or sliced from the timber species specified under 3.1. Sap wood shall not be permitted in veneers.

4.2 The thickness of veneers shall not exceed 3 mm.

4.3 The grain in veneers shall be straight and shall run parallel to the edges, except as permitted under 4.4.

4.4 The slopes of the grain from the edge of the veneer shall be not greater than 1 in 12 nor shall the slope of the grain from the plane of veneer be greater than 1 in 12.

4.5 The veneer shall be reasonably free from irregular grain, such as short grain, wavy grain and wild grain.

4.6 The veneers shall be conditioned to a moisture content of 8 to 10 percent.

*Specification for synthetic resin adhesives for plywood (phenolic and aminoplastic).

4.7 Veneers when cut shall be reasonably smooth so as not to interfere with adhesion.

4.8 Veneers shall not have any of the following defects:

- a) Brash wood,
- b) Checks,
- c) Decay,
- d) Dote,
- e) Discolouration due to sap stain,
- f) Patching,
- g) Ingrown bark,
- h) Birds eye,
- j) Filling and inlaying.

4.8.1 Harmless discolouration due to chemical action or adhesive stain, not associated with decay shall be permissible.

4.9 Face veneers shall be free from open defects, such as insect holes, splits, pitch pockets and pin worm holes. They shall be free from large, loose or dead knots, but may contain small live knots of diameter not greater than 6 mm provided that the sum of the diameters of the dead knots in any 1 000 cm² does not exceed 10 mm.

4.10 The following defects shall be permissible in core veneers:

- a) Live or dead knot of width not exceeding 6 mm or length in grain direction not exceeding 12 mm, provided that the sum of the widths and lengths in the grain direction of the knots does not exceed 10 mm and 18 mm respectively in any 1 000 cm². Holes may be present in the knot.
- b) Closed split of width not exceeding 0.25 mm.

4.11 Bird pecks of the extent as shown in Fig. 1 and burr not exceeding as shown in Fig. 2 are admissible.

4.12 Joints in Veneers

4.12.1 All joints shall be square cut. Plies may contain edge joints.

4.12.2 All joints in core plies shall be edge glued. Joints in face plies shall be either edge glued or taped and the tape shall be removed from the board before delivery.

4.12.3 End grain joints, that is, joints running across the width of the veneer at right angles to the grain direction shall not be permitted.

4.13 Assembly of Veneers

4.13.1 Unless otherwise specified, the grains of adjacent plies in a board shall run at right angles to each other throughout the board.

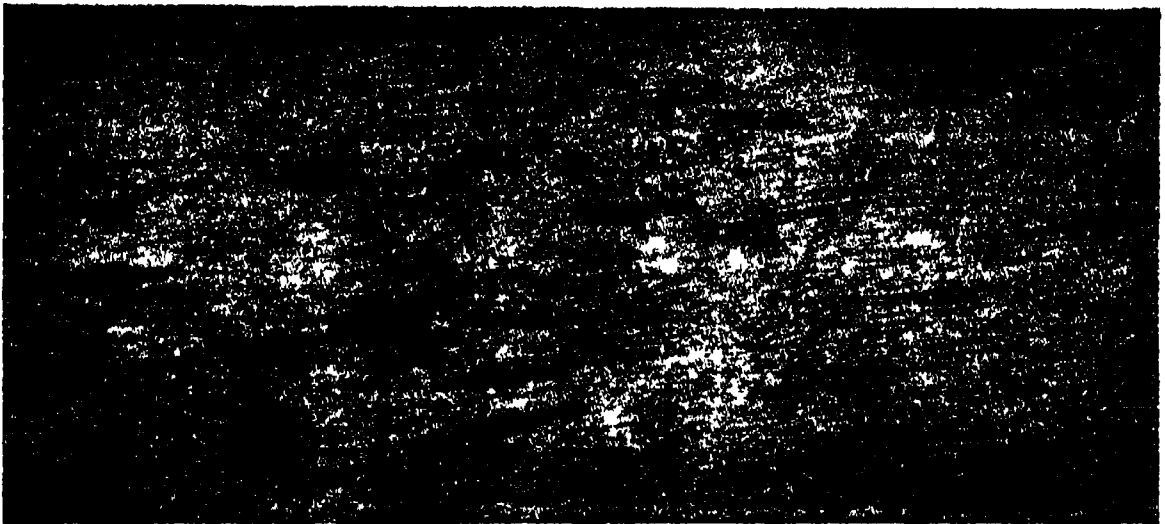


FIG 1 BIRD PECKS (NATURAL SIZE)

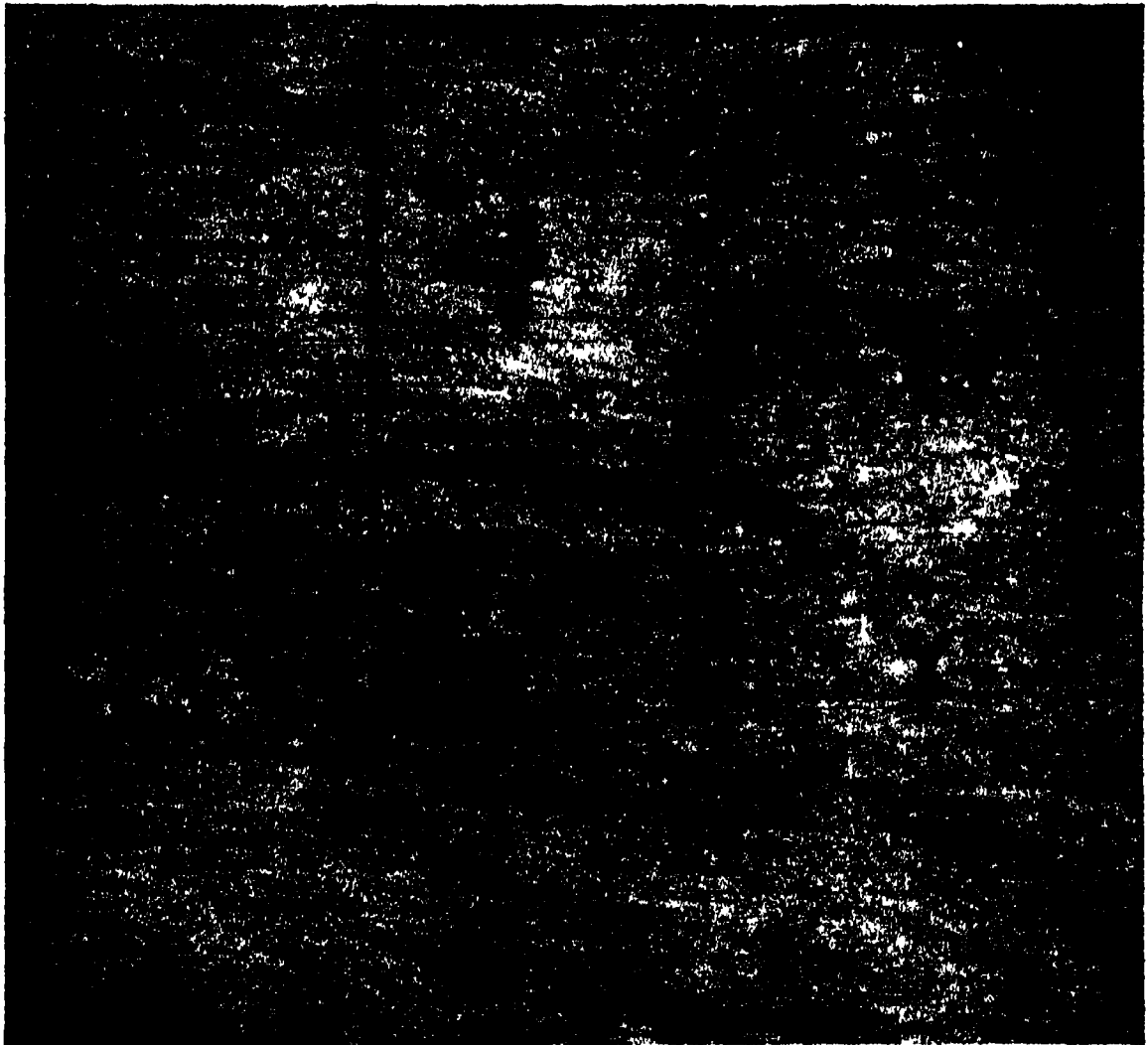


FIG 2 BURR (NATURAL SIZE)

4.13.2 Unless otherwise specified, the grains of the outer plies in a board shall run parallel to the length of the board.

4.13.3 The construction of the board shall be balanced, that is, corresponding plies on opposite sides of the core ply shall be of the same species, thickness and grain direction. All the veneers of a board shall be cut by the same method that is either sliced or rotary-cut.

4.13.4 The thickness of any veneer in multi-ply shall not exceed twice the thickness of any other veneer in the same board.

4.13.5 The thickness of the core veneer in 3-ply shall be neither less than one-third nor greater than five-twelfths of the nominal thickness of the board.

4.14 Bonding

4.14.1 The glue used in the manufacture of plywood shall be as specified under 3.2.

4.14.2 The gluing shall be done in suitable hot-plate presses. The manufacturing details shall be controlled so as to produce uniform high-quality adhesion throughout.

4.15 Scarf Joints in Boards — There shall be no scarf through the thickness of a board.

4.16 Treatment of Boards — Immediately the boards are taken out of the press and whilst they are still hot, they shall be dipped in a 2 percent solution of sodium pentachlorophenate in water or a two percent solution of pentachlorophenol in a suitable organic solvent at room temperature and allowed to dry.

NOTE — Sodium pentachlorophenate is likely to precipitate on acidification. It should, therefore, be periodically checked and brought up to proper concentration.

5. SIZES AND THICKNESS OF BOARDS

5.1 Unless otherwise specified, plywood shall be supplied as rectangular boards of the following sizes:

180 × 120	cm
150 × 120	„
120 × 120	„
180 × 90	„
150 × 90	„
120 × 90	„

5.2 Unless otherwise specified, boards shall be made in thicknesses as specified in Table 2.

5.3 The thickness of any board shall be considered as the average of ten or more measurements taken at random.

6. FINISH

6.1 The edges of the board shall be trimmed square.

TABLE 2 THICKNESS OF BOARDS

THICKNESS	TOP LIMIT	BOTTOM LIMIT
(1)	(2)	(3)
mm	mm	mm
1.00	1.10	0.90
1.50	1.65	1.35
2.00	2.20	1.80
2.50	2.75	2.25
3.00	3.30	2.75
3.50	3.68	3.33
4.00	4.20	3.80
4.50	4.73	4.28
5.00	5.25	4.75
6.00	6.30	5.70
7.00	7.35	6.65
8.00	8.40	7.60
9.00	9.45	8.55
10.00	10.50	9.50

6.2 The finished sheets shall be smooth and free from blisters, overlaps, pleats, gaps and open joints. The surface shall be free from oil wax, paraffin, tape and any other substance which may prevent adhesion of glue or paint finishes.

6.3 The board shall be sanded on both faces.

7. ADHESION OF PLYES

7.1 The adhesion of plies shall be tested by forcibly separating the layers. The veneers shall offer appreciable resistance to separation and the fractured samples shall show some adherent fibres distributed more or less uniformly. Adhesion may also be tested by knife test described in Appendix A of IS:709-1957*. When tested for glue adhesion by the method described in Appendix A the average failing load shall not be less than 135 kg and no individual value shall be less than 100 kg.

8. RESISTANCE TO WATER

8.1 The adhesion of plies after three hours of immersion of the test pieces in boiling water shall conform to all the requirements given in 7.1. The test pieces shall be approximately of size 25×10 cm and shall be obtained by cutting the specimen from the board in such a way that the length of the test piece is parallel to the grain of the face veneers. From these species after immersion in water specimen of size 150 mm long and 25

*Specification for medium strength aircraft plywood.

mm wide shall be cut as prepared for glue adhesion test. In the glue adhesion test, the average failing load shall be not less than 90 kg and it shall be not less than 70 kg for any individual specimen.

8.2 After immersion in boiling water for 72 h the test pieces shall not show any sign of separation at the edges of the veneers or formation of blisters, and shall not fail entirely on the glue line on forcible separation.

9. MOISTURE CONTENT

9.1 The moisture content of the test pieces shall be between 8 to 12 percent when tested in accordance with Appendix B.

10. STRENGTH

10.1 Transverse Strength—When tested in accordance with Appendix C for bending to constant radius around a mandrel, the plywood shall not show any sign of fracture.

10.2 Shear Strength

10.2.1 Not less than two specimens shall be tested for shear strength from each board selected as given in 11.1.

10.2.2 The shear strength shall be determined as described in Appendix D.

10.2.3 The average of all tests shall be not less than 175 kg/cm². No specimen shall give a test value less than 160 kg/cm².

11. MARKING

11.1 The following particulars shall be legibly and indelibly stamped on one side of each board:

- a) Name of manufacturer or trade-mark, if any;
- b) Number of specification;
- c) Veneer species (symbol);
- d) Thickness of board;
- e) The type of adhesives used;
- f) Date of manufacture; and
- g) Batch number and press load number.

11.1.1 Each board may also be marked with the ISI Certification Mark.

NOTE—The use of the ISI Certification Mark is governed by the provisions of the Indian Standards Institution (Certification Marks) Act, and the Rules and Regulations made thereunder. Presence of this mark on products covered by an Indian

Standard conveys the assurance that they have been produced to comply with the requirements of that standard, under a well-defined system of inspection, testing and quality control during production. This system, which is devised and supervised by ISI and operated by the producer, has the further safeguard that the products as actually marketed are continuously checked by ISI for conformity to the standard. Details of conditions, under which a licence for the use of the ISI Certification Mark may be granted to manufacturers or processors, may be obtained from the Indian Standards Institution.

12. SAMPLING

12.1 For the purpose of tests, samples shall be drawn as given in Table 3 at random from each batch.

TABLE 3 NUMBER OF BOARD TO BE SAMPLED FROM EACH BATCH

SIZE OF BATCH (NO. OF BOARDS OF ANY SIZE)	NO. OF SAMPLES TO BE SELECTED
(1)	(2)
Less than 50	2
51 to 100	4
101 „ 200	5
201 „ 250	6
251 „ 500	7

13. TENDERED SAMPLES AND INSPECTION

13.1 Tendered Samples — The manufacturer shall submit six 3-ply boards of any size (*see* 5.1 for sizes) in each type of plywood in various thicknesses for type to the purchaser.

NOTE — The samples and requirements in this standard are for 3-ply construction. The corresponding values for multi-ply construction will be specified when experience is gained in the manufacture and large scale use of high strength aircraft plywood.

13.1.1 Before any manufacturer's type of plywood is approved for use it shall have passed the type tests which shall be conducted at an approved laboratory or testing station.

13.2 Inspection — Veneers shall be inspected individually before gluing for conformity to the requirements given in 4.

13.2.1 All joints in veneers shall be inspected individually before assembly into boards.

13.2.2 The board shall be inspected for freedom from warp and conformity to the requirements specified in 5 to 10.

APPENDIX A

(Clause 7.1)

METHOD OF TEST FOR GLUE ADHESION

A-1. OBJECT

A-1.1 This test is intended to estimate the tenacity with which the bonding material holds the veneers together.

A-2. TEST SPECIMEN

A-2.1 At least two test specimens shall be cut from the board. The test pieces from 3-ply plywood shall be prepared by making saw cuts (see Fig. 3).

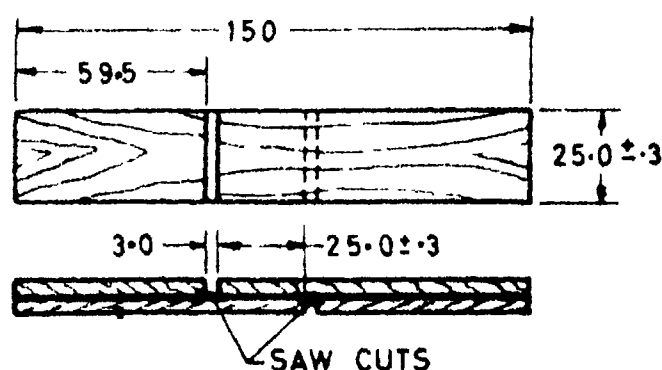
A-2.2 When the number of plies exceeds three, the plywood shall be stripped of all except any three selected plies either by chiselling or by planing. The stripping shall be done so as to test any two of the adjoining glue joints, provided at least half the number of the specimens so tested includes the innermost glue joint. The test specimen shall be prepared by making saw-cuts as shown in Fig. 3.

A-2.3 The specimen shall be conditioned, where required, to a moisture content between 10 to 14 percent before the test is carried out.

A-3. PROCEDURE

A-3.1 Each test specimen shall be gripped at two ends in the jaws of a suitable machine, and shall be pulled apart. The pull should be as far as possible in the centre line of the central veneer. The grain of the centre ply shall be perpendicular to the direction of application of load.

A-3.2 During the test, the load shall be applied to the test specimens as uniformly as possible, and so adjusted as to increase at a rate of approximately 270 kg/min.



All dimensions in millimetres.

FIG. 3 TEST SPECIMEN FOR GLUE ADHESION TEST

A-3.3 The maximum load at the time of complete failure of each specimen shall be recorded. Record shall also be made as to failure whether in wood or in glue by visual examination of the area under shear. In case of wood failure the percentage wood failure shall also be recorded. Measurement shall be made of the width of the bonding surface and length of bonding surface under shear.

A-3.4 In case of persistent wood failure of more than 50 percent due to thin veneers not more than 1.2 mm thick, the test shall be carried out by reducing the length of shear area in between the grooves from 2.5 to 1.25 cm. The shear strength of each specimen shall be calculated by multiplying the failing load by 1.8.

A-4. REPORT

A-4.1 Shearing strength of the specimens determined in accordance with **A-3** shall be straight averaged and compared to values given in **10.2.3**.

A-4.2 In case wood failure in an individual specimen is more than 50 percent, and the load at which the test specimen fails is less than the average, the value for such specimen shall be discarded for the purpose of averaging the shear strength.

A-4.3 The percentage of wood failure shall also be reported.

A P P E N D I X B

(Clause 9.1)

DETERMINATION OF MOISTURE CONTENT

B-1. PROCEDURE

B-1.1 A small sample, about 5 cm square shall be weighed (W_1) and shall then be dried in an oven at a temperature of 100° to 105°C until the weight is constant (W_o).

B-2. CALCULATION

B-2.1 The moisture content shall be calculated as follows:

$$\text{Percentage of moisture} = \frac{W_1 - W_o}{W_o} \times 100$$

where

W_1 = weight of the original sample, and

W_o = oven-dry weight of the sample.

B-3. PRECAUTION

B-3.1 Care shall be taken to prevent any change in moisture content between the cutting of the sample and the first weighing and between removal from the oven and subsequent weighing.

A P P E N D I X C

(*Clause 10.1*)

DETERMINATION OF BENDING STRENGTH**C-1. TEST SPECIMENS**

C-1.1 Test specimen shall be cut from each selected board in such a manner that:

- a) the length of the test piece is parallel to the grain direction of the face plies, and
- b) a joint shall run along the axis of the test specimen, if there are such joints in the sheet.

C-1.2 The specimens shall be cut with the minimum slope of grain from the edges.

C-1.3 The specimens shall be oven dry at the time of test.

C-1.4 The specimen shall be 25 mm wide and of sufficient length, so that when bent over a mandrel of the specified diameter a parallel sided U is formed.

C-2. PROCEDURE

C-2.1 The ratio of the diameter of the mandrel to the thickness of the plywood shall be as specified in Table 4.

C-2.2 The specimens shall be bent at the specified radius to a parallel sided U shape without support on the tension side. The specimen shall be bent once and bent again in the reverse directions.

C-3. EXAMINATION

C-3.1 The test specimen shall then be examined visually for fractures and separation of the plies. Breakage shall consist of fractures extending 3 mm or more across the width of the specimen. Tears along the fibre direction that begin at the edge and extend into the specimen along the grain sloping from the edge shall not be considered breakage. It shall be determined whether a specimen breaks before removal from the mandrel. Breakage of more than 20 percent of all the specimens tested shall be considered as the cause for rejection of the whole lot.

TABLE 4 BENDING TEST
(*Clause G-2.1*)

PLYWOOD THICKNESS	MANDREL DIAMETER
mm	mm
1.0	100
1.5	150
2.0	200
2.5	250
3.0	300
3.5	350
4.0	400
4.5	450
5.0	500

A P P E N D I X D

(*Clause 10.2.2*)

DETERMINATION OF SHEAR STRENGTH

D-1. PROCEDURE

D-1.1 Test specimens shall be cut to a size 15×10 cm with the longer edges parallel to the grain direction of the face plies.

D-1.2 Loading blocks *A* and supporting blocks *B* made from any hardwood of moisture content 8 to 12 percent shall be glued to the plywood specimen as shown in Fig. 4. Cross stripe *C*, also made of hardwood, shall be glued to supporting blocks *B* only. The dimensions of the blocks and their spacing shall be as shown in Fig. 4.

D-1.3 The assembly shall be placed on the compression table of a standard testing machine such that the supporting blocks rest square on the base and the load shall be applied axially on the loading blocks at a uniform rate of approximately 455 kg/min. The shear strength is given

by the formula:

$$F_s = \frac{P}{2 \times t \times w}$$

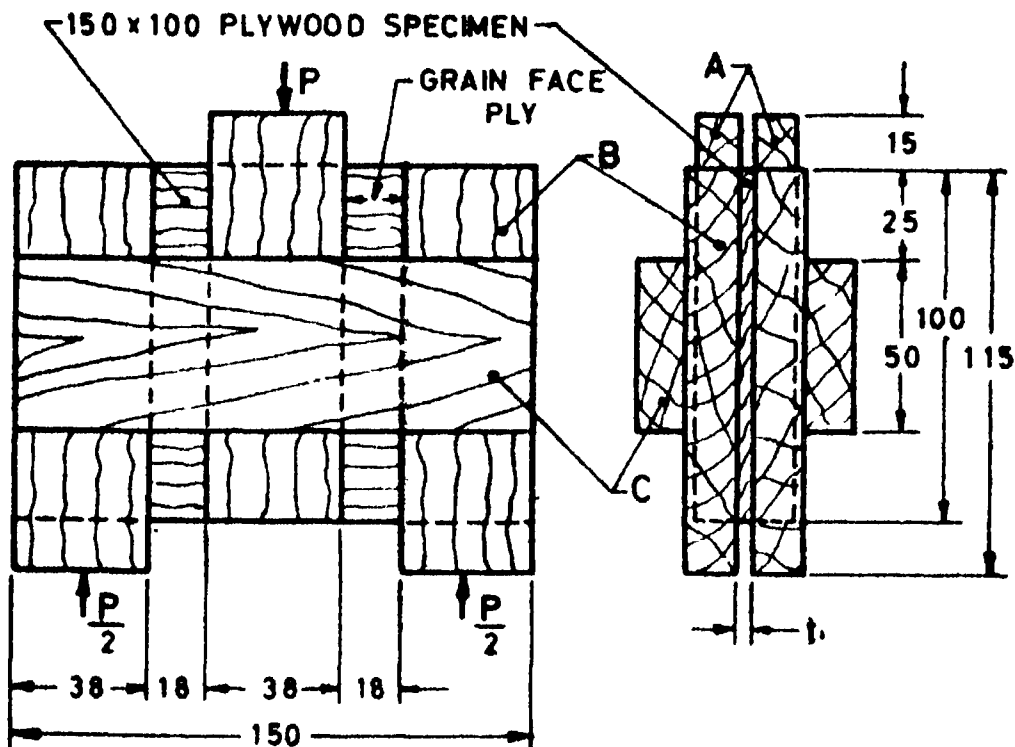
where

F_s = shear strength in kg/cm²,

P = ultimate load in kg,

t = thickness of plywood in cm, and

w = width of specimen in cm.



SIZES OF LOADING BLOCKS			
Description	Length	Width	Thickness
Block A	115	38	13
Block B	115	38	15
Block C	150	50	15

All dimensions in millimetres.

FIG. 4 PLYWOOD SHEAR TEST

INTERNATIONAL SYSTEM OF UNITS (SI UNITS)

Base Units

QUANTITY	UNIT	SYMBOL
Length	metre	m
Mass	kilogram	kg
Time	second	s
Electric current	ampere	A
Thermodynamic temperature	kelvin	K
Luminous intensity	candela	cd
Amount of substance	mole	mol

Supplementary Units

QUANTITY	UNIT	SYMBOL
Plane angle	radian	rad
Solid angle	steradian	sr

Derived Units

QUANTITY	UNIT	SYMBOL	DEFINITION
Force	newton	N	1 N = 1 kg.m/s ²
Energy	joule	J	1 J = 1 N.m
Power	watt	W	1 W = 1 J/s
Flux	weber	Wb	1 Wb = 1 V.s
Flux density	tesla	T	1 T = 1 Wb/m ²
Frequency	hertz	Hz	1 Hz = 1 c/s (s ⁻¹)
Electric conductance	siemens	S	1 S = 1 A/V
Electromotive force	volt	V	1 V = 1 W/A
Pressure, stress	pascal	Pa	1 Pa = 1 N/m ²

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Printed at Simco Printing Press, Delhi, India